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(54) Abstract Title

Deposition apparatus

(57) An apparatus for depositing a layer of material on to a workpiece includes chamber 11, a sputter target 12, a wafer support 13, wafer transport aperture 14 and a wafer transport mechanism 15. The wafer transfer mechanism delivers the wafers along a transport path 16. An annular shield 19 is disposed between the support 13 and the target 12 and lies in the wafer transport path 16. Pins 30 are provided to lift the annular shield out of the transport path 16.

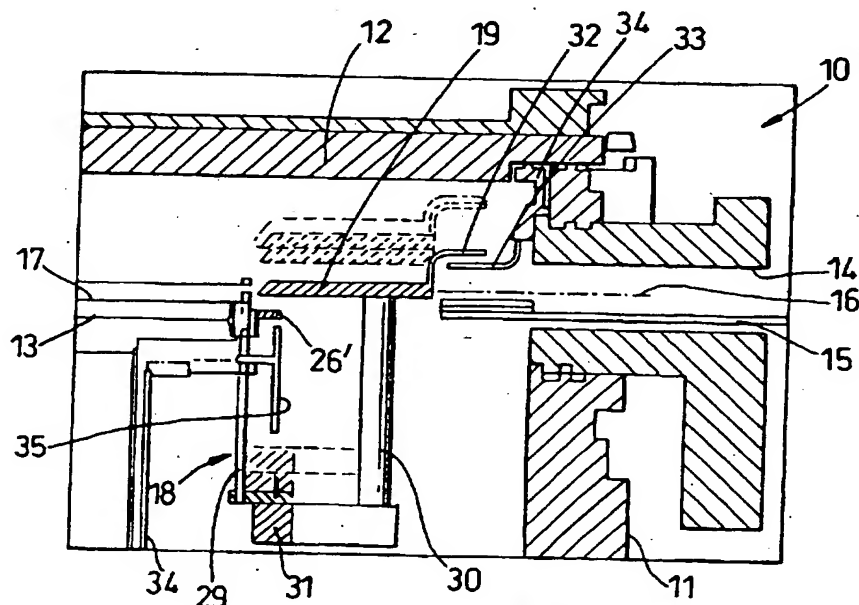


Fig. 8

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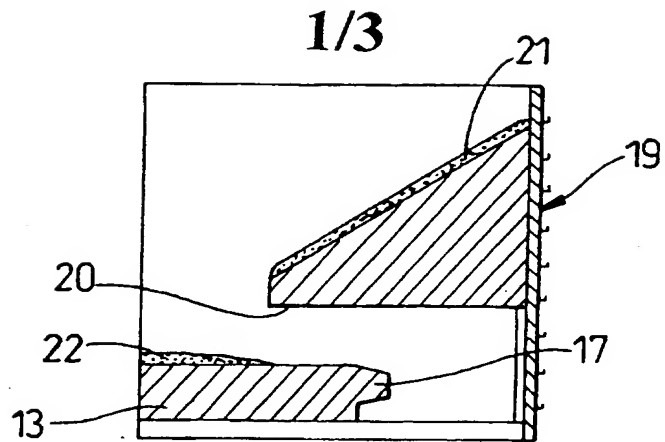


Fig. 1

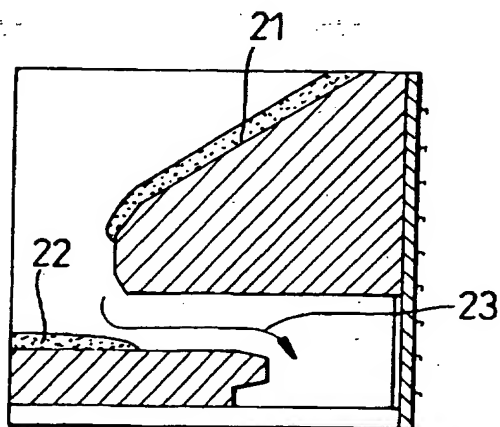


Fig. 2

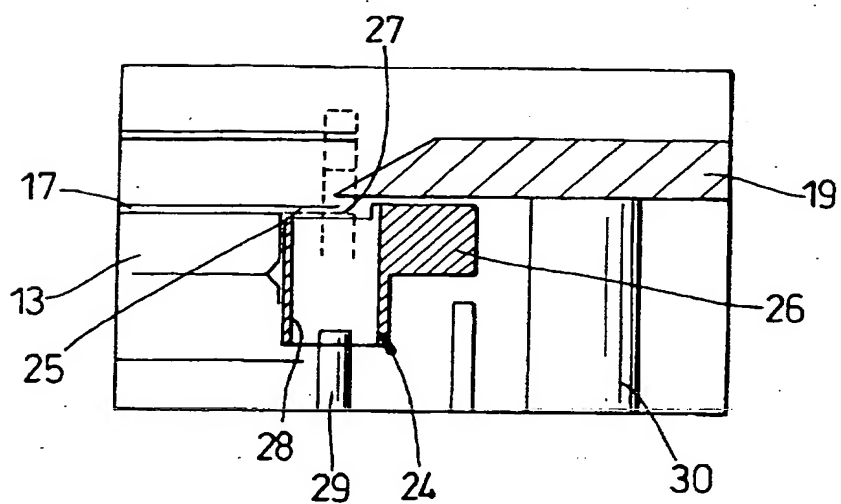


Fig. 3

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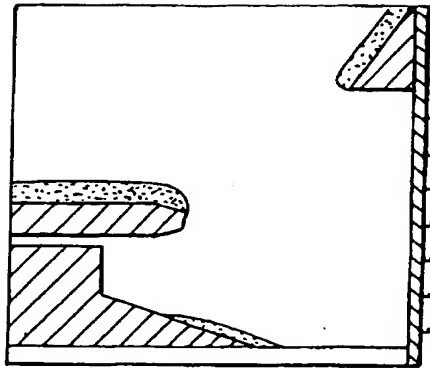


Fig. 4

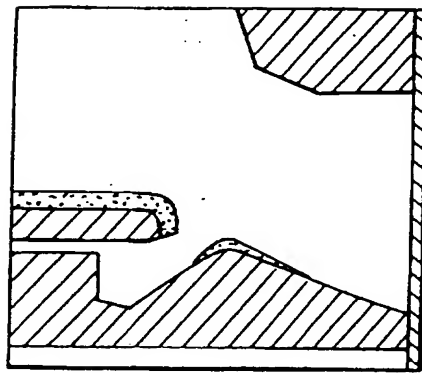


Fig. 5

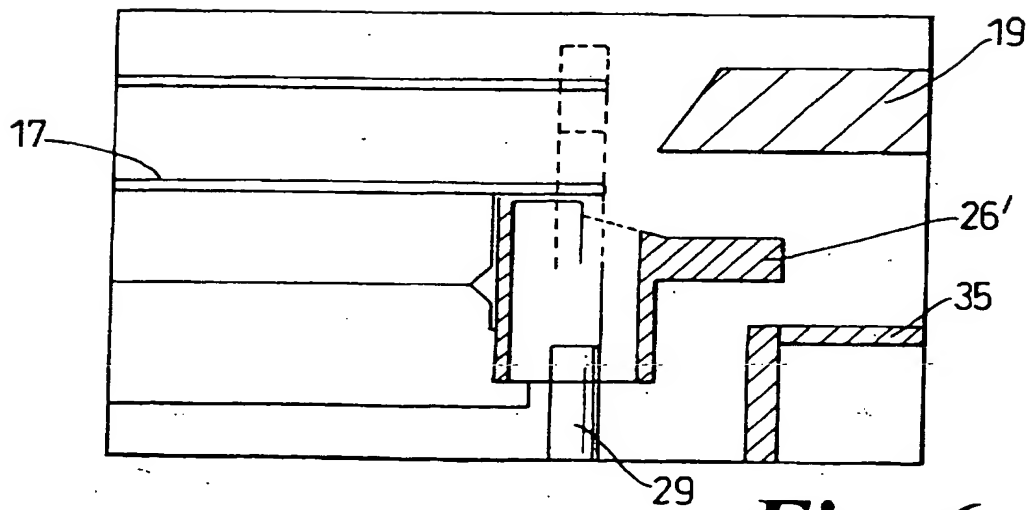


Fig. 6

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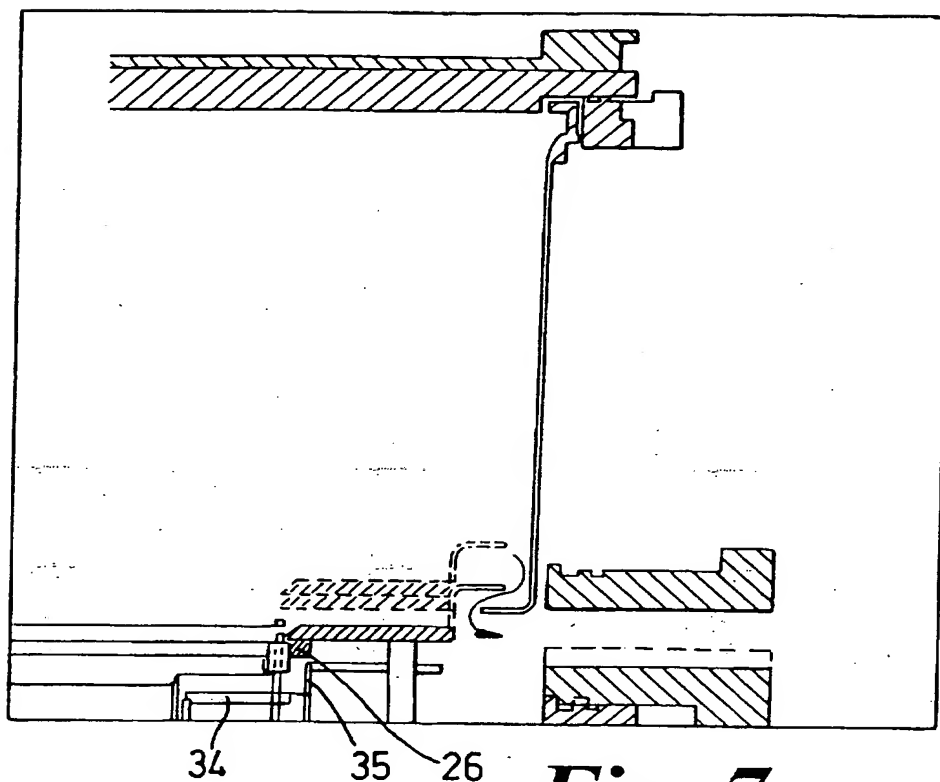


Fig. 7

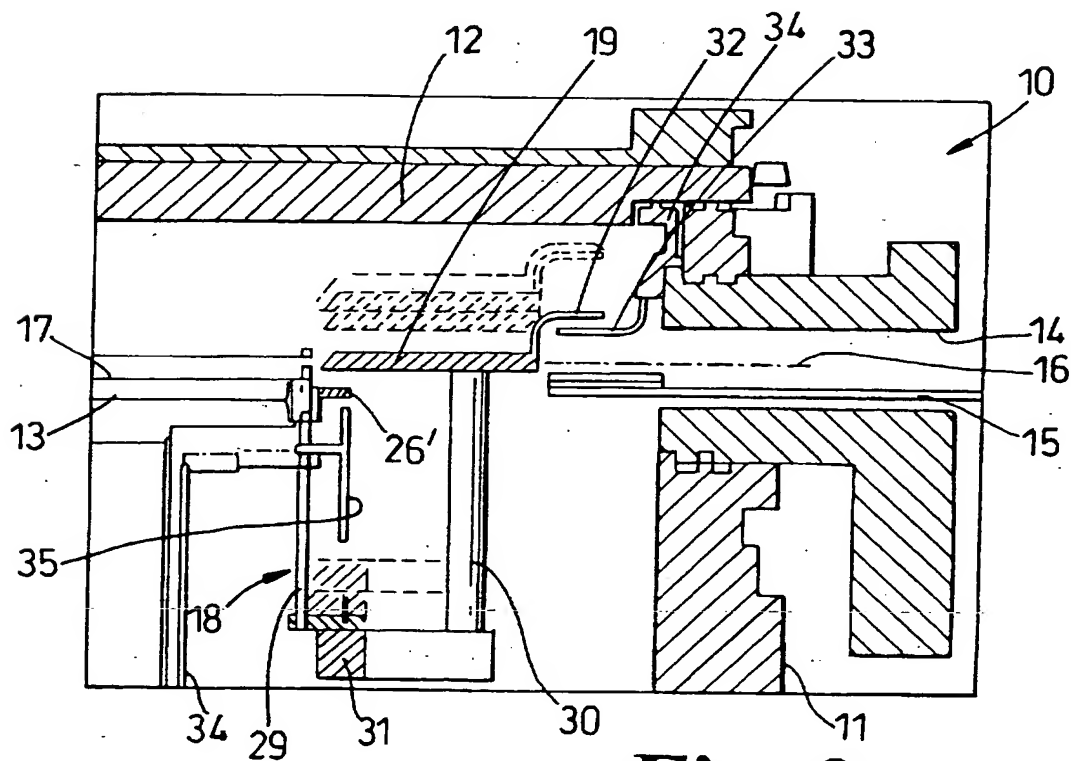


Fig. 8

"Deposition Apparatus"

This invention relates to a apparatus for depositing a layer of material on to a workpiece.

In many manufacturing processes, including the manufacture of semi-conductor devices, sensors and MEMS, there is a need to deposit layers or thin films of materials onto workpieces. In physical vapour deposition there is a source of material within a chamber whereby material is ejected from the source onto the workpiece to form a layer. The source of material may be a sputter target or it may be an evaporated source or some other source of material that forms at least part of a deposited layer. In any of these cases the material tends to be deposited not only on the workpiece but also on other parts of the chamber in which the process has taken place. Traditionally, the solution has been to cover all long term exposed surfaces with removable shields. Workpieces are usually located on a support and providing shielding around and below the support can be particularly awkward, because such shields can be expensive to form and difficult to locate, given that it is desirable that no threaded fasteners should be used within a chamber, because of the danger of creating damaging particles.

Particular problems arise in connection with the support and the workpiece. Two manufacturing situations tend to exist. The first is where the workpiece is smaller than the support and lies within its periphery. In that case extra deposited material can affix the workpiece to the

support or can build up on the surface of the support causing incorrect seating of subsequent workpieces. The second situation is where the workpiece overhands the support. In this arrangement it effectively shields the support, but unwanted deposition can occur on both the edge and the back side of the workpiece. (In some situations manufacturers do require deposition on the edge).

The best solution proposed to date to this problem has been to provide a fixed shield which overlies the periphery of the workpiece and the support, but this has a number of disadvantages. First it tends to preclude deposition on the edge of the wafer, when that is desirable, and secondly it makes the loading of workpieces on to the support extremely complex. Essentially the whole support has to be moved away from the shield so as to give sufficient room for the wafer to be lifted from the support and then removed by a transport mechanism. As very frequently the support will have electrical, cooling and mechanical connections, the need to move the support introduces significant expense and complication.

From one aspect the invention consists in apparatus for depositing a layer of material onto a workpiece including a chamber, a source of material, a workpiece support for supporting a workpiece with an exposed surface facing the material source onto which a layer is deposited, means for loading and unloading the workpiece along a transport path and a shield disposed between the support and the material source for limiting the amount of material deposited on or

adjacent to the periphery of the support or workpiece characterised in that the shield lies in the transport path and in that the apparatus further comprises a mechanism for moving the shield out of the transport path during loading
5 and unloading.

The apparatus may further comprise a further shield surrounding the support for shielding the back of the periphery of the workpiece and, in some embodiments, the further shield may shield the edge of the workpiece.

10 It is preferred that, when in its shield position, the first-mentioned shield forms a labyrinth path with the support, the further shield and/or the workpiece. To enhance this labyrinth path the further shield may have a radial extension.

15 The apparatus may further comprise means for lifting and lowering the workpiece into or from the transport path and these lifting and lowering means may incorporate or be linked to the mechanism for moving the shield so that as the workpiece is lifted off the support, the shield moves out of
20 the transport path. The lifting/lowering means may include a liftable frame carrying a first set of pins for engaging the workpiece and a second set of pins for engaging the shielding. The second set of pins may serve as the support for the first mentioned shield, when it is in its shielding
25 position as well as during movement of the shield.

The further shield may fall away as it extends radially outwardly to allow greater deposition to take place on its surface before the deposition upon it builds up to a level

to contact the workpiece backside, or interfere with workpiece transportation.

The chamber may have or define a ledge formation and in that case the first mentioned shield may have a corresponding and cooperating formation whereby, when the first mentioned shield is in its shielding position, the formations form a labyrinth.

The first-mentioned shield will have a shape which is generally dictated by the shape of the periphery of the workpiece e.g. for a generally circular semi-conductor wafer, the first-mentioned shield will be generally annular.

From a further aspect the invention consists in apparatus for depositing a layer including a source of material, a workpiece support, a first shield for shielding the back periphery of a workpiece on the support and a second shield, interposed between the source and the first shield to shield the first shield.

Although the invention has been defined above it is to be understood that it includes any inventive combination of the features set out above or in the following description.

The invention may be performed in various ways and specific embodiments will now be described, by way of example, with reference to the accompanying drawings in which:

Figure 1 illustrates a computer simulation of an edge shield, a workpiece and a workpiece support after a single deposition cycle;

Figure 2 is a corresponding simulation after a sputter

target has been consumed;

Figure 3 is a detailed cross-section taken at the area of the edge of a support and the corresponding shielding of one embodiment of the invention;

5 Figures 4 and 5 correspond to Figures 1 and 2 for a different embodiment of the invention and Figure 6 corresponds to Figure 3 for that different embodiment;

10 Figure 7 is a cross-sectional view of a more substantial part of the chamber in which the embodiment of figure 3 is utilised; and

Figure 8 is a corresponding view to Figure 7 for the embodiment of Figure 6.

Referring first to Figures 7 and 8 a deposition apparatus is generally indicated at 10 and includes a
15 chamber, generally indicated at 11, a sputter target 12, a wafer support 13, wafer transport aperture 14 and a wafer transport mechanism 15, which is shown schematically. The wafer transport mechanism 15 delivers the wafers along a transport path, which is indicated at 16.

20 As will be described in more detail below semiconductor wafers 17 can be lifted from the support 13 by a lift mechanism generally indicated at 18. In this way they can be lifted into the transport path 16 and conversely lowered from that path onto the support 13.

25 An annular shield 19 is disposed between the support 13 and the target 12 and in fact lies in the wafer transport path 16 for reasons which will be set out below.

Turning now to Figures 1 to 3 the relationship between

the annular shield 19, the wafer 17 and the wafer support 13 can be seen in more detail. Thus in Figures 1 and 2 it can be seen that the leading edge 20 of the annular shield 19 overhangs the wafer 17, which in turn overhangs the support 13. As can be seen the layer of deposited material 21 builds up on the annular shield 19 as the cycles take place and this increases the shielded area, without too significantly affecting the deposition 22 on the wafer.

To an extent this simulation in Figures 1 and 2 is equally applicable to the present embodiment and the previously described prior art arrangement. However, as has been mentioned, the position of the annular shield 19 can present loading and unloading problems and also, although a labyrinth path 23 is created between the wafer 17 and the annular shield 19, this is not necessarily sufficient to protect against back deposition on the wafer.

As can be seen in Figure 3 the applicants overcome the second of these problems by providing a further annular shield 24 around the periphery of the support 13 so that it underlies the overhanging portion 25 of the wafer 17 and thus prevents deposition on that portion. The further shield has a radial extension 26 which upstands to protect the edge 27 of the wafer 17 and the extension 26 also extends along the under surface of the shield 19 to increase the efficacy of the labyrinth path 23.

As can be seen in Figure 3, apertures 28 are formed in the back shield 24 to allow lifting pins 29 to pass therethrough and lift the wafer 17 from the support 13. The

annular shield 19 is supported on another set of pins 30 and, as can be seen in Figure 8 both sets of pins are carried by a ring 31. The ring can be lifted so that as the first set of pins 29 lift the wafer 17 and the second set of pins 36 lift the annular shield 19 out of the transport path 16 allowing the wafer transport mechanism 15 to remove the lifted wafer 17 and replace it with the next one. Once the following wafer is loaded on the first set of pins 29, the ring 31 is lowered so that the wafer 17 is placed on the support 13 and the annular shield 19 returns to its operative position.

It will be seen that the annular shield 19 carries an L-cross section element 32 at its outer edge which is arranged to cooperate with a ledge 33 on the inner chamber shielding 34. These two ledges 32, 33 prevent most material passing down below the annular shield 19, but provide a serpentine pump down path as illustrated by the arrow in Figure 7.

Turning to Figures 4 to 6 and 8, a corresponding arrangement is illustrated for the situation where it is desired to be able to deposit material on the edge of the wafer 17. In this case annular shield 19 does not extend to cover that edge, but rather acts as a shield to limit material being deposited upon the radial extension 26' which falls away from the exposed edge, whilst still maintaining the labyrinth.

This inclined construction of the extension 26' means that it takes a significant period for the material, which

does get deposited thereon, to build up to a level at which it would interfere with the seating of the wafer 17 or the transport thereof. Otherwise, this arrangement operates in a similar manner as the arrangement illustrated in Figures 1 to 3 and 7.

Extra shielding is provided at 34 and 35.

The arrangements discussed above provide a very elegant solution to the problem described. Indeed it has been found that the shielding is such that repeatable and consistent deposition on wafers can be achieved for the whole life of a target without any need to replace the shielding and without unwanted back deposition or edge deposition, where that is shielded against. The arrangement avoids the need for movement of the support between each wafer, although a progressive movement of the support towards the target could take place to compensate for the fact that the target is being consumed. The arrangement is particularly convenient in that case, because it allows for corresponding adjustment of the position of the shields, simply by altering the rest position of the ring. The transport path location can equally be adjusted.

In certain processing arrangements pre-set positions for the support and annular shield 19 may be selected to suite particular processing phases. The above arrangement is still beneficial both because it can provide shielding of the backshielding, in the Figures 4 to 6 and 8 arrangement in particular, and because it enables the annular shield position in the transfer plane to be one of the options.

CLAIMS

1. Apparatus for depositing a layer of material on to a workpiece including a chamber, a source of material, a workpiece support for supporting a workpiece with an exposed surface facing the material source onto which a layer is deposited, means for loading and unloading the workpiece along a transport path and a shield disposed between the support and the material source for limiting the amount of material deposited on or adjacent to the periphery of the support or workpiece characterised in that the shield lies in the transport path and in that the apparatus further comprises a mechanism for moving the shield out of the transport path during loading and unloading.
2. Apparatus as claimed in Claim 1 further comprising a further shield surrounding the support for shielding the back of the periphery of the workpiece.
3. Apparatus as claimed in Claim 1 or Claim 2 wherein, in its shield position, the first mentioned shield forms a labyrinth path with the support, the further shield and/or the workpiece.
4. Apparatus as claimed in Claim 2 or Claim 3 as dependent on Claim 2 wherein the further shield has a radial extension.
5. Apparatus as claimed in any one of the preceding claims further comprising means for lifting and lowering the workpiece into or from the transport path.
6. Apparatus as claimed in Claim 5 wherein the lifting/lowering means incorporates or is linked to the

mechanism for moving the shield.

7. Apparatus as claimed in Claim 6 wherein the lifting/lowering means includes a liftable frame carrying a first set of pins for engaging the workpiece and a second
5 set of pins for engaging the shielding.

8. Apparatus as claimed in Claim 2 or any one of Claims 3 to 7 as dependent on Claim 2 wherein the further shield shields the edge of the workpiece.

9. Apparatus as claimed in Claim 2 or any one of Claims 3
10 to 7 as dependent on Claim 2 wherein the further shield falls away as it extends radially outwardly to allow deposition to take place on the edge of the workpiece.

10. Apparatus as claimed in any one of the preceding claims wherein the chamber has or defines a ledge formation and
15 wherein the first mentioned shield has a corresponding and cooperating formation whereby, when the first mentioned shield is in its shielding position the formations form a labyrinth.

11. Apparatus for depositing a layer including a source of
20 material, a workpiece support, a first shield for shielding the back periphery of a workpiece on the support and a second shield interposed between the source and the first shield to shield the first shield.

12. Apparatus for depositing a layer substantially as
25 hereinbefore defined with reference to the accompanying drawings.



Application No: GB 9910724.5
Claims searched: 1-10 & in part 12

Examiner: Pete Beddoe
Date of search: 3 August 1999

Patents Act 1977 Search Report under Section 17

Databases searched:

UK Patent Office collections, including GB, EP, WO & US patent specifications, in:

UK CI (Ed.Q): C7F (FEF, FEH, FEX)

Int CI (Ed.6): C23C (14/00, 14/04, 14/56)

Other: Online: WPI, EPODOC, JAPIO

Documents considered to be relevant:

Category	Identity of document and relevant passage	Relevant to claims
X	WO 96/35823 A1 (SEAGATE) see esp p12 lines 18-25 & fig 2	1 at least
X	WO 86/06753 A1 (SEAGATE) see esp p11 lines 9-21 & fig 2	1 at least
X	US 5660114 (SEAGATE) see esp col4 lines 36-49 & col6 lines 35-41	1 at least
X	US 5259881 (MATERIALS) see esp col8 lines 31-35 & figs	1 at least
X	US 4828668 (SEMICONDUCTOR) see esp col1 line 46 - col2 line 22 & figs 1,2	1 at least
X	WPI Accession no 97-369943 & JP 9157839 A (HITACHI) see abstract (incl fig)	1 at least

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